

**PROPOSED SPECIFICATION  
DIAL EQUIPMENT  
For Central Offices Up to 500 Lines**

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Prepared By  
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0. GENERAL

- 0.1 These specifications cover minimum requirements and types of services to be provided by dial telephone central office equipment for exchanges of 500 lines or less.
- 0.2 Unusual conditions may require that these specifications be amended to meet individual situations. Any deviations, however, from these specifications shall be set forth in the contract between the purchaser and the supplier.
- 0.3 These specifications shall apply in particular to the equipment involved in dial conversions and in so far as practicable to additions to existing exchanges.
- 0.4 Installation shall be performed by the supplier, where possible, under the supervision of the suppliers engineers. Performance tests shall be made on the equipment to the satisfaction of the purchaser as part of the installation requirements.

1. DIAL SWITCHING EQUIPMENT

- 1.1 The central office equipment shall provide a means of connecting any dial subset in the exchange to any other dial subset in the exchange or to an available inter-office trunk without the aid of an operator. Each subset shall be connected with the central office by not more than two conductors.
- 1.2 All cabling shall be designed to insure that the cross-talk level of the switchboard fully connected shall be at least 60 decibels below the level of the input signal to a disturbing line. Conductors carrying ringing current shall be cabled so as to insure against induction in talking circuits.
- 1.3 Switchboard cable and cable forms shall be made with soft annealed tinned copper wire of suitable cross section to provide ample and safe current carrying capacity and mechanical strength. Wire insulation shall be synthetic resin material or enamel with cotton and silk covering.
- 1.4 The maximum permissible noise level in the equipment shall be 40 db. above reference noise level ( $10^{-12}$  watts).





- 1.5 Ringing shall be completely automatic and intermittent and shall be cut off from the called line instantaneously upon removal of the receiver or handset at the called station.
- 1.6 The equipment shall be completely wired and equipped with trouble signals, fuses, and all associated equipment for its wired capacity of switches. Individual circuit fuses shall be of the alarm and indicator type, so that alarms will be given when a fuse is blown.
- 1.7 If the office is of the unattended type means shall be provided for transmitting an alarm indication to an attended office as well as indicating the alarm condition locally by means of lamps. By dialing a code set aside for that purpose it shall be possible for the operator to determine whether the non-standard condition is of a major or minor nature.
- 1.8 The minimum visual and transmitted alarms shall be as follows:
- | <u>Urgent Alarms</u>  | <u>Non Urgent Alarms</u>                             |
|---|--|
| A. Fuse Failure   | A. Permanent condition (line selector and connector) |
| B. High or low voltage  | B. Ringing machine transfer 2nd set OK               |
| C. Call blocked   | C. Interrupter transfer 2nd set OK                   |
| D. Failure of equipment in a communication channel to restore to normal |  |
| E. Ringing machine transfer 2nd set faulty                              |  |
| F. Interrupter transfer 2nd set faulty                                  |  |
| G. Rectifier failure  |  |
| H. Fire   |  |
- 1.9 Equipment units shall be suitably designated and numbered to make it possible to readily trace calls and facilitate the location of trouble.
- 1.10 The switchboard and individual relay racks shall be furnished with suitable terminal blocks for connection to all external circuits and all necessary wiring shall be brought out and terminated on these terminal blocks.
- 1.11 Unless otherwise specified the equipment shall be arranged so that the following classes of service may be offered to subscribers in the exchange area:
- A. Flat rate individual line - bridged ringing
  - B. Flat rate two party - bridged full selective frequency ringing





- C. Flat rate four or five party - bridged full selective frequency ringing
- D. Flat rate eight or ten party - bridged 1 and 2 ring semi-selective frequency ringing or divided full selective frequency ringing
- E. Flat rate PBX or trunk - bridged ringing (appropriate to type of hunting consecutively numbered lines service required)
- F. Post pay paystation - same as individual line except with tone equipment

- 1.12 The central office equipment shall operate satisfactorily with subscriber lines having a loop resistance up to 1200 ohms including the telephone instrument and a minimum leakage between conductors or between either conductor to ground of 15,000 ohms with 10 ringers on a bridged ringing basis.
- 1.13 The central office equipment shall operate satisfactorily when used with dials whose speed of operation is between 8 - 12 impulses per second for local traffic and 21 impulses per second for incoming toll traffic. The break period should be between 58 to 64 percent of the total impulse period.
- 1.14 The central office equipment shall be so designed that whatever the initial intra-office trunking requirement might be, it can be expanded to permit a possible 15% trunking per 100 lines without re-wiring the existing equipment.
- 1.15 Tones shall be provided to indicate the progress of a call through the exchange: dial tone - to indicate that the switching equipment is ready to receive dial impulses, busy tone - to indicate that a busy line has been encountered, ring back tone - to indicate to the calling subscriber that the line called is being rung, all trunks busy tone - to indicate that the calling subscriber should try to make his call at some later time.
- 1.16 Automatic timed disconnect shall be applied at any switching stage in the central office should a "permanent" condition occur on a line. When the "permanent" is cleared the line shall automatically be re-connected to the central office equipment in a normal manner.
- 1.17 It shall be possible for subscribers on the same party line to call each other. When such a revertive call is made the local link should be released and talking battery supplied from the line circuit.
- 1.18 The equipment should be so arranged that during periods of light





traffic successive calls from the same line will take different paths thru the switching equipment. Trunking shall be arranged for the maximum facility of connection and shall be arranged within each line finder group so that a blocked call does not prevent other calls from being established. Means shall be provided in the switchboard to insure approximately equal duty for each switch or relay group seized in initiating a call. Failure or cutting out any links shall in no way impair the automatic rotation feature.

- 1.19 Switchboards of 100 lines or smaller capacity shall be designed so that any calling line in the switchboard shall have direct access to the total number of line finders provided in that switchboard.
- 1.20 All incoming inter office trunk circuits shall terminate on incoming selectors. In the case of free service trunks to another office a busy condition will cause busy tone to be received by the calling subscriber. If the trunks carry toll traffic a busy line condition shall be indicated to the toll operator by a flashing signal (60 IPM) on her supervisory lamp in addition to the normal busy tone. An all trunks busy condition from selector levels shall be indicated to the toll operator by a 120 IPM flash and no tone.
- 1.21 Facilities for postpay paystation service shall be provided. A call to an operator from a paystation shall cause a spurt of tone of from 0.5 to 0.75 second duration to be heard by the operator when she plugs into the answering jack. It shall be possible to repeat the tone signal by removing and re-inserting the plug in the jack. Paystation numbers shall be arranged so that the fourth digit from the last is 9 to correspond to nationwide intertoll dialing plan.
- 1.22 It shall be possible to meter the central office equipment to obtain counts on the following:
  - A. Linefinder peg count per group
  - B. Linefinder "all trunks busy" condition
  - C. Incoming selector peg count
  - D. Outgoing trunk peg count
  - E. Local selector overflow (per level per shelf)
  - F. Terminating traffic peg count per group
- 1.23 When a toll operator encounters a busy line condition the operator shall be able to remain on the line and allow the supervisory lamp to continue flashing until the line becomes idle, at which time the line shall be seized and rung automatically. The operator shall receive the appropriate on-hook and off-hook supervision.





- 1.24 Verification facilities shall be provided whereby an operator may override a busy condition. Verification shall be accomplished by means of a suffix or prefix digit to the subscribers directory number.
- 1.25 To permit a toll operator to seize a line without ringing it shall be possible for the operator to withhold the ringing digit until such time as she is ready to complete the call. While the line is seized it shall be busy to all other calls. If the called party attempts to originate a call the operator shall receive off-hook supervision on the supervisory lamp and be able to talk. If the line is busy the operator shall receive busy tone until the line becomes idle at which time the busy tone shall be removed and the line seized and busied to any other caller.
- 1.26 Where only one connector group is required it shall be possible to cause the connectors to hunt over a group of 10 or less lines to provide consecutive number line service or PBX service. If several groups of connectors are provided, one group shall be arranged for such trunk hunting.
- 1.27 Suitable long line adapters shall be provided when required.
- 1.28 Itemized lists of spare parts and maintenance tools as recommended by the supplier shall be provided for the purchaser's consideration.
- 1.29 Screw threads for all threaded securing devices shall be of American National form in accordance with the National Bureau of Standards Handbook H-28. All bolts, nuts, screws and washers shall be of nickel-copper alloy, steel, brass or bronze.
- 1.30 All threaded securing devices such as those used for securing parts or complete assemblies to the supporting structure of any component shall conform to the national coarse thread series, class 2 fit.
- 1.31 All threaded devices used for adjustment purposes shall conform to either the national coarse or fine thread series as required.
- 1.32 All bolts used shall be sufficiently long to insure that, when nuts are screwed home, there shall be at least 2 threads projecting clear from the outer face of the nut. The length of the threaded portion on all bolts and nut ends of studs shall be not less than 1-1/2 times the bolt or stud diameter. Unless otherwise specified, studs shall engage the part into which they are set for a length equal to at least one diameter and shall be securely staked.
- 1.33 Threads shall not be employed in molded or laminated plastic parts without the use of suitably threaded metallic inserts, except in in-





stances where the use of the inserts would adversely affect the electrical or mechanical characteristics of the item or part.

- 1.34 Self tapping screws will not be acceptable.
- 1.35 All switch units and relays shall be enclosed in quickly removable dust proof covers.
- 1.36 Each relay group or automatic switch unit shall be individually fused.
- 1.37 All relay and motor magnet coils shall be of the self protecting type, capable of being continuously energized at rated voltage without injurious results.
- 1.38 The switchboard or each 100 line group shall contain a suitable test circuit to facilitate routine testing of the equipment.
- 1.39 All finishes shall have a high resistance to moisture and to other factors which might tend to cause corrosion.
- 1.40 No ceramic, untreated fiber, or wood treated or untreated, shall be used in the construction of the switchboard or associated equipment.

## 2.0 MAIN DISTRIBUTING FRAME

- 2.1 A suitable main distributing frame shall be furnished appropriate to the individual situation.
- 2.2 Each line actually in use shall be protected in the central office against high voltage and extraneous currents.

## 3.0 TEST EQUIPMENT

- 3.1 All lines and trunks shall be tested from the main distributing frame.
- 3.2 Two hand test telephones, a routine test set and simplified wire chief's test facilities shall be furnished.
- 3.3 The wire chief's test set shall include a high resistance two scale voltmeter (volts and ohms), an operators telephone circuit, dial circuit, outgoing trunk to dial equipment and the necessary test keys. The following test features shall be provided for:
  - A. Test for bridged foreign E. M. F.
  - B. Test of exchange battery





- C. Test for short circuits
- D. Test for open circuits
- E. Test for grounds
- F. Test for tip negative potential
- G. Test for ring negative potential
- H. Test condenser in subscribers set
- I. Supply talking battery to the line
- J. Ring subscriber
- K. Test in and out of exchange
- L. Test heat coils

#### 4.0

#### POWER EQUIPMENT

- 4.1 The switching equipment shall operate satisfactorily over a voltage range of from ~~44~~ - 52 volts d.c.
- 4.2 The central office battery shall provide a minimum reserve of 5 busy hours when the exchange reaches the size which it is calculated to be 10 years hence.
- 4.3 The principal ringing current source may be operated from the commercial a.c. voltage. However, adequate standby equipment shall be provided to operate from the central office battery.
- 4.4 Battery and charger control switches, voltmeter, ammeter, frequency meter, fuses, ringing relays, supervisory and timer circuits shall be provided. The equipment shall be wired and equipped to insure that standby ringing supply will automatically cut in to service upon failure of the a.c. supply or at any other time that the output of the regular ringing source falls below normal.
- 4.5 Charging equipment shall be manually turned on and off and shall be of the full wave, self regulating, constant voltage, dry disc type. The rectifier capacity shall be sufficient for full float charging of the battery for continuous service when the exchange reaches the size which it is calculated to be 10 years hence.
- 4.6 The rectifier output voltage shall be 51.6 volts and shall not vary more than  $\pm .35$  volt between 10% load and 100% load. Between 0% and 10% load the output voltage shall not vary more than  $\pm .5$  volt. Beyond full load current the output voltage shall drop sharply. The above output voltage limitations shall be maintained with line voltage variations of  $\pm 10\%$  and frequency variations of  $\pm 5\%$ . Provision shall be made for an equalization charge after an a.c. power failure.
- 4.7 The maximum r.m.s. value of the alternating component (ripple) of the rectifier shall be as low as practicable and shall in no case





exceed 0.05 volts at the terminals of the rectifier with the battery connected.

## 5.0 MISCELLANEOUS

- 5.1 A floor plan layout drawing indicating the arrangement of the equipment in detail, giving all dimensions both plan and elevation for all units of equipment shall be furnished. The floor plan shall allow for growth as anticipated by the purchaser.
- 5.2 A switching diagram drawing shall be included indicating switching arrangement, switch quantities and traffic distribution.
- 5.3 The supplier shall make recommendations concerning measures to be taken to insure adequate ventilation and heating.
- 5.4 All circuit drawings with circuit descriptions shall be submitted for the purchaser's approval prior to manufacture.
- 5.5 Four complete sets of equipment, circuit, circuit description, wiring list and job drawings shall be furnished the purchaser at the time of delivery of the equipment.
- 5.6 The supplier shall defend, at his own expense, all suits or proceedings against the purchaser and pay any award of damages which may be assessed in such suits and proceedings against the purchaser arising from the purchase and use of the equipment specified herein.

## 6.0 TESTS AND TEST PROCEDURES

- 6.1 All equipment purchased under these specifications shall be thoroughly tested by the supplier to insure proper operation of same in accordance with these specifications. Materials and workmanship throughout shall be of a good commercial grade.
- 6.2 The dielectric strength between electrical circuits and between electrical circuits and ground shall withstand a 500 volt r. m. s. a. c. 60 cycle breakdown test. In all dielectric tests the voltage shall be raised gradually to the specified value and held at that value for one minute and then gradually reduced.
- 6.3 The insulation resistance of electrical circuits following the dielectric strength test shall not be less than 10 megohms at 500 volts d. c. at approximately room temperature (75° F.) and at a relative humidity of approximately 50%.
- 6.4 The switchboard under test shall be capable of successfully passing





at anytime the following general performance test: Two complete telephones shall be connected through the switchboard in the designed manner. A complete cross-board circuit check shall be made using the two telephones and each telephone shall call the other telephone as many times as there are links or trunks in the switchboard circuit. Each call shall be made in the following manner: The handset of the calling telephone shall be removed from the desk, whereupon dial tone shall be received in the receiver of the calling telephone. The calling telephone observer shall dial the number of the called telephone whereupon ring-back tone shall be heard in the receiver of the calling telephone and the ringer of the called telephone shall ring. Finally the handset of the called telephone shall be removed from the desk, and a conversation held between observers to indicate a completed circuit. During the test, all signalling and switching operations shall be observed carefully and any deviation from the normal shall be noted.

- 6.5 Tests to determine the degree of cross-talk shall be connected with the switchboard fully connected while the switchboard is being, or immediately after it has been, exposed to a temperature of 105° F. (40.5° C.) and relative humidity of 90-95 percent for a period of at least 48 hours. Tests for cross-talk shall be made with the switchboard connected for normal operation and energized from the power equipment which the contractor proposes to furnish. Tests shall be made with the rectifier and batteries connected to the switchboard in the normal manner. The power supply leads to the switchboard shall be of minimum length for this test. Two complete telephone channels shall be established through the switchboard by means of the telephone station equipment. One of the lines used shall be located as near the center of the switchboard cable as possible. Center tapped 500 ohm resistors balanced to ground shall be substituted for the telephone stations. The telephone channel using the line in the center of the switchboard cable shall be designated as the disturbing line and the other as the idle or disturbed line. The disturbing line shall be energized by connecting the output of an oscillator across the terminals of the line. The power supplied to the disturbing line by the oscillator shall be such that the a.c. voltage impressed across the line shall be 20 volts at 1000 cycles. Voltage measurements shall be made on the disturbed and disturbing lines, and from this data the cross-talk level of the switchboard shall be calculated.
- 6.6 It shall be possible for all components of equipment to meet the requirements of this specification at any ambient temperature within the range of 20° F. (-6.8° C.) to 120° F. (49° C.) and at a humidity of 90-95% except as otherwise noted. The following procedure will





be used on this test.

- 6.7 For testing at an ambient temperature of 20° F. (-6.8° C.) all equipment connected for normal operation, shall be kept in an ambient temperature of 20° F. (-6.8° C.) for a period of 24 hours. General performance tests shall be made at frequent intervals as the temperature of the test chamber is being lowered, during the 24-hour test period, and while the temperature of the test chamber is being raised slowly to room temperature.
- 6.8 For testing at an ambient temperature of 120° F. (49° C.) all equipment, connected for normal operation shall be kept in a dry oven at an ambient temperature of 120° F. (49° C.) for a period of 24 hours. The 24-hour period will begin when the temperature of the test chamber and the apparatus under test has become stabilized at 120° F. (49° C.). General performance tests shall be made at frequent intervals, as the temperature of the test chamber is being raised, during the 24-hour test period, and while the temperature of the test chamber is being lowered slowly to room temperature.
- 6.9 Immediately following the test at 120° F. (49° C.) the switchboard shall be tested for a period of 48 hours in an ambient temperature of 120° F. (49° C.) and a relative humidity of 90 to 95 percent. General performance tests shall be made at frequent intervals throughout the test run.
- 6.10 Relays representative of those used in the equipment shall be subjected to a relay contact reliability test. All the relay contacts shall be connected in series and 3000-cycle current supplied by an oscillator shall be passed through the series contacts to actuate a facsimile recorder. The relay operating coil shall be energized and de-energized at the constant rate of 75 operations per minute. The recorder shall supply a continuous record of the relay contact operations. Relays shall complete 500,000 operations of opening and closing without any contact failure in order to be considered satisfactory for relay contact reliability. During this test the relays under test shall be kept in a dustproof chamber in order to standardize the test.
- 6.11 Relays representative of those used in the equipment shall be given a relay contact life test. The relays shall be tested as indicated in 6.10 above with the exception that the relay contacts shall interrupt load currents and voltages comparable to those that the relays would encounter under normal operating conditions. A relay contact shall be considered to have a satisfactory life if after 100,000 operations there is no contact failure and a visual examination reveals no excessive wear or pitting.





- 6.12 One of each type of rotary switch used in the dial telephone equipment shall be tested. The wipers and each switch shall be made to rotate at the speed of normal switchboard operation. Each switch tested shall perform 100,000 revolutions without any failure or excessive wear. The switch shall be lubricated and adjusted immediately after 50,000 revolutions. The bearings, springs, contacts and all other parts shall be examined at the end of the test for evidence of wear or damage and shall show no excessive wear.
- 6.13 One of each type of non-rotary stepping switch used in the dial telephone equipment shall be tested. The switches under test shall be wired in a circuit simulating normal operating conditions and the wipers shall be stepped electrically to each bank contact in numerical sequence then released. One cycle of operations shall consist of stepping to, contacting with, and releasing from each and every bank contact in the bank normally associated with the switch under test. Two motion switches and single motion switches shall complete 5,000 cycles of operation without failure, excessive wear, or damage. The switch shall be lubricated and adjusted immediately after 2500 complete cycles of operation. The bearings, springs, contacts and all other parts shall be examined at the end of the test for evidence of wear or damage.
- 6.14 One of each type of manually operated switch shall be operated with normal current for 100,000 operations. There shall be no failures or visible wear.



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